Nature Conservation 46: 49–62 (2022)
doi: 10.3897/natureconservation.46.76036
https://natureconservation.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
Nature Conservation
Launched to accelerate biodiversity conservation

Drivers of snow leopard poaching and trade in Pakistan and implications for management

Jaffar Ud Din[1,2], Fathul Bari[3], Hussain Ali[1,4], Ejaz ur Rehman[1], Durriyyah Sharifah Hasan Adli[2], Nurul Ashikin Abdullah[2], Yusoff Norma-Rashid[2], Muhammad Kabir[6], Shoaib Hameed[1,4], Doost Ali Nawaz[1,7], Muhammad Ali Nawaz[5]

1 *Snow Leopard Foundation, 44000 Islamabad, Pakistan* **2** *Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia* **3** *Department of Zoology, University of Chitral, Khyber Pakhtunkhwa, Pakistan* **4** *Department of Zoology, Quaid-i-Azam University, 44000 Islamabad, Pakistan* **5** *Department of Biological and Environmental Sciences, Qatar University, Doha, Qatar* **6** *Department of Forestry and Wildlife Management, University of Haripur, Khyber Pakhtunkhwa, Pakistan* **7** *Department of Environmental Sciences, International Islamic University, 44000 Islamabad, Pakistan*

Corresponding author: Muhammad Ali Nawaz (nawazma@gmail.com)

Academic editor: Mark Auliya | Received 2 October 2021 | Accepted 23 January 2022 | Published 1 March 2022

http://zoobank.org/AA392DC1-2DF9-4F01-8635-F16BE11AC695

Citation: Din JU, Bari F, Ali H, Rehman E, Adli DSH, Abdullah NA, Norma-Rashid Y, Kabir M, Hameed S, Nawaz DA, Nawaz MA (2022) Drivers of snow leopard poaching and trade in Pakistan and implications for management. Nature Conservation 46: 49–62. https://doi.org/10.3897/natureconservation.46.76036

Abstract

The snow leopard is one of the highly valued species from high-altitude mountain ecosystems of Central and Southeast Asia, including Pakistan. This keystone species is facing a myriad of conventional and emerging threats, including poaching and trade, that are poorly documented in Pakistan. To understand the dynamics and drivers of the poaching and trading of snow leopards in Pakistan, we investigated the issue in depth through a multifaceted survey in the snow leopard range of the country. We recorded 101 snow leopard poaching incidences from 11 districts during 2005–2017. The reported poaching incidences varied spatially ($\bar{x}$ = 9 ± 2.6 [95% Cl: 3–15]) and temporally ($\bar{x}$ = 7.8 ± 1.09) and accounted for 2–4% annual population loss (n = 200–420) in a period of 13 years. Poaching and trade together constituted 89% of the total incidence reported and animals were mostly shot (66%), poisoned (12%), snared (12%) and captured (4%), respectively. Only a fraction (3%) of the incidences were reported to the relevant law enforcement agencies. Trade routes included large cities and neighbouring countries, even the Middle East and Europe. The average base and end prices for each item were 245 ± 36 USD and 1,736 ± 520 USD, respectively, while maximum monetary fines set as per the law were 275 USD. Our results establish the

Copyright *Jaffar Ud Din et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

need for developing multi-stakeholder coordination mechanisms at regional, national and international levels and information sharing to curb this menace. Improving the existing laws and surveillance system, while taking the local communities onboard, will further help to this end.

Keywords
conflict, illegal trade, northern Pakistan, pelt, poaching; retaliatory killing

Introduction

The global illegal wildlife trade has grown to be the second largest black market after narcotics and has accelerated the risk of extinction of many threatened species (Toledo et al. 2012). The consequences of poaching and trafficking of wildlife are not only limited to biodiversity loss, but also poses a threat to national and global security, economy and human and animal health (Gómez and Aguirre 2008; Bending 2015; Carter and Linnell 2016). The net worth of the global illegal wildlife trade is difficult to estimate. It is said to be USD 5–20 billion annually (Hansen et al. 2012; Bending 2015), which constitutes around 30% of all wildlife trade of the global market, placing it next to narcotics and arms trade (Oldfield 2003). Despite the combined efforts of the international community, governments and civil societies to counter wildlife trafficking, it continues to rise in recent years (Vié et al. 2009). Factors contributing to the poaching of wild animals vary according to socio-cultural, religious and economic situations. Thus, the motivations behind wildlife poaching and trade are a multifaceted phenomenon and vary across the globe (Kahler and Gore 2012; Ayling 2013). Poaching of large carnivores is particularly complex to understand from the relevant perspective as the human-carnivore relationship involves numerous socioecological factors, which are difficult to control when resources are limited and the consequences are far greater (Ripple et al. 2014; Carter and Linnell 2016).

Snow leopard (*Panthera uncia*) dwells in the mountain ranges of Pamir, Karakoram, Hindu Kush and the Himalayas over an area of 80,000 km^2 potential range (Sheikh and Molur 2004) and is listed as a critically endangered species in Pakistan. With a debatable global status and population estimates of between 4000–8000 cats in the wild, poaching remains one of the main threats to snow leopards, found ubiquitously throughout its range in Central and South Asia (McCarthy et al. 2017; Ale and Mishra 2018). Since 2008, some 221–450 cats have been killed annually across the 12 range countries (Nowell et al. 2016). Although seizure records with the legal and official authorities for snow leopard poaching in Pakistan are limited, yet expert surveys indicate poaching of 23–53 snow leopards annually in the country, which is disproportionately higher than the country's share in the global snow leopard range (Nowell et al. 2016).

Pakistan became a member of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1976, but lack resources, expertise and tools that limit the enforcement of provisions and relevant laws, like many other countries (Dexel and Deutschland 2002). Impacts of loopholes and weak enforcement of laws regulating wildlife poaching and trade are not only restricted to the country it-

self, but also have implications for neighbouring countries (Yi-Ming et al. 2000). This is most valid for Pakistan where the northern parts of the country share borders with other countries of the snow leopard range. Pakistan is one of the countries where species regulated under CITES are traded, whereas harvesting of species listed in Appendix-I is illegal and those in Appendix-II require certain regulations, depicting weak law enforcement and inadequate capacity for monitoring wildlife crimes (Aisha and Khan 2016). The marketing of wild animals and their products in the cities of Peshawar, Lahore and Karachi has a long history, which remained in practice after the creation of Pakistan. Laws protecting wildlife and endangered species in Pakistan evolved progressively over the last 50 years (Aisha and Khan 2016). However, during these years, gaps and poor enforcement of the existing laws have encouraged and benefited the wildlife crimes in the country. Studies reveal that some reasons for the continuation of this practice are: (a) weak enforcement of wildlife protection laws, (b) constraints and deficiencies in human and financial resources to protect and monitor the vast, difficult access areas, (c) imperfection and gaps in the existing regulations related to wildlife trade and protection and (d) differences in laws protecting snow leopard poaching at regional and national level (Yi-Ming et al. 2000). In the national context, one such example of weakness in the laws can be seen in the case of snow leopard poaching where the minimum penalty is 30,000 Pakistani Rupees (PKR) (approx. USD 180) and a maximum punishment is six months imprisonment (KP Wildlife Department 2015), while the pelt and other body parts thus obtained can generate thousands of US Dollars (Theile 2003). Thus, the possible punishment is underweighted against the potential financial gains. Moreover, the growing use of modern technology, such as the advent of internet and particularly social media, has greatly increased the chances and ways to trade wildlife species illicitly (Lavorgna 2014; Aisha and Khan 2016).

Poaching and illegal trade are some of the main risks for the species of wildlife of the country, such as snow leopards, common leopards and black or brown bears. While it is thought that snow leopards and other carnivores' pelts and other products entering the trade market are usually killed in retaliation to livestock predation, poaching for merely monetary gain cannot be neglected (Hussain 2003; Kabir et al. 2014; Nowell et al. 2016). Other factors contributing to snow leopard poaching are their use in traditional medicines, but in Pakistan, such practices are not known, rather poaching is taken as a matter of honour, bravery and pride, which could be a major driver of the practice (Khan 2002a; Li and Lu 2014). In previous studies on wildlife poaching and trade, the focus has been on major markets, cities and experts' opinions. These studies reflect an alarming situation of wildlife poaching and trade in the country, but little evidence is available from the legal agencies and intergovernmental authorities on the issue (Khan 2002b; Aisha and Khan 2016). Similarly, the motivation behind poaching, particularly that of snow leopard, has not been addressed. It indicates that the issue is not known to the legal agencies and first-hand information is not available to the line departments.

It can be assumed that all types of poaching and trade of snow leopards and their products on the national or international market, which are originating from Pakistan, would be from the snow leopard range of the country. Even if these are happening in some bordering countries, they might first enter and appear in the snow leopard range

because this area connects with neighbouring countries via several unchecked and unregulated routes and passes. Until now, no such attempt has been made to quantify the level of snow leopard poaching and trade in the high-altitude areas where the species dwell. Although a very discouraging situation of active prosecution and marketing of snow leopards was reported by Khan (2002a, b) from market surveys in different cities of Pakistan. However, it is unknown from where these pelts and products originated.

It is then irrefutable that little or no attempts have been made in the areas where these incidences occur. The main drivers of poaching and this black market in the snow leopard range of Pakistan, which is critical for the conservation of snow leopards, are also not well known. This may be partly due to financial and other restrictions in reaching far-flung areas, in addition to lack of indigenous knowledge of the area and people who are involved at the grassroots level in poaching and trade of wild animals.

This study is aimed at investigating the dynamics and drivers of snow leopard poaching and trade in Pakistan. The study also focuses on the possible routes and destinations of snow leopard products exported from and imported to the country during a period of 13 years (2005–2017).

Study area

The current study was conducted in Pakistan. The snow leopard range in the country spreads over an area of 80,000 km^2 in the northern mountainous belt, including the Hindu Kush, Pamir, Karakoram and Himalayas (MOCC 2017) and is the main focus of this study. Administratively, the snow leopard range covers the entire Gilgit-Baltistan (GB) Province, Chitral, Kohistan and Swat Districts of Khyber Pakhtunkhwa (KP) Province and Neelum District of Azad Jammu & Kashmir (AJ&K), respectively (Fig. 1). The GB Province contains the largest proportion (> 60%) of the country's snow leopard range (Hussain 2003; Din et al. 2021). Pakistan's snow leopard range also borders India, China and Afghanistan and constitutes an important corridor enabling genetic diversity. In addition to the snow leopard range, the study also surveyed major cities, including Rawalpindi, Islamabad, Lahore, Swat and Peshawar, to collect data on the snow leopard trade.

Methods

Since the investigation of wildlife poaching and trafficking is a sensitive issue and cannot be ascertained through a single method, the researchers used a mix of investigative tools in this study (Fig. 2). The survey was conducted from December 2017 to June 2018. Firstly, we distributed structured questionnaires to the wildlife staff in each district and provincial or regional headquarters to gather reported, pursued and prosecuted cases of snow leopard and other carnivores during the study period, i.e. 2005–2017. A total of 11 districts wildlife offices in three provincial departments were surveyed during the study, along with three non-governmental conservation organisations operating in the snow leopard range to gather the required information. Next, we surveyed potential pelt markets in major cities outside the snow leopard range includ-

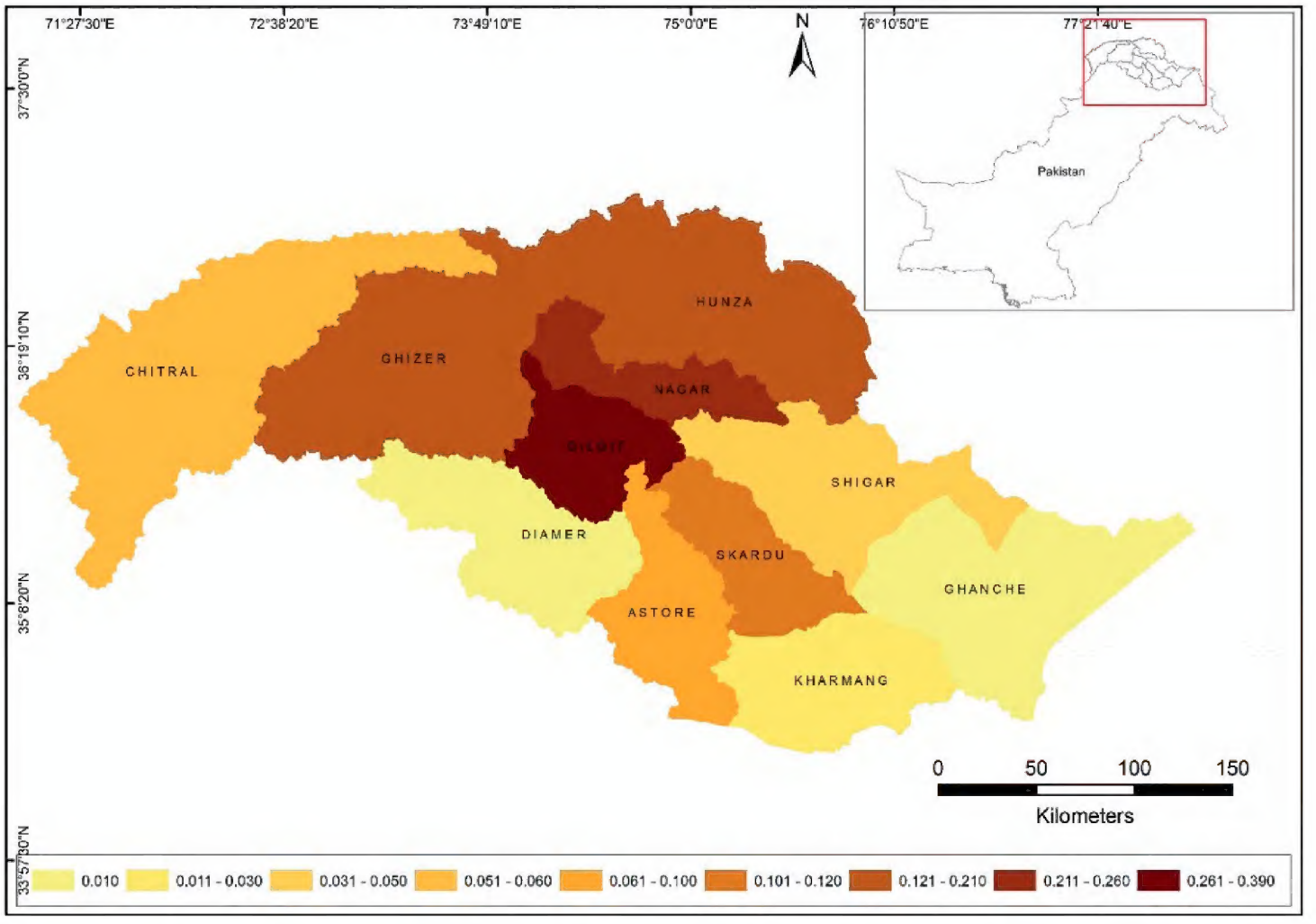

Figure 1. Map of the study sites showing the intensity of snow leopard poaching per 100 km2 during the study period (2005–2017).

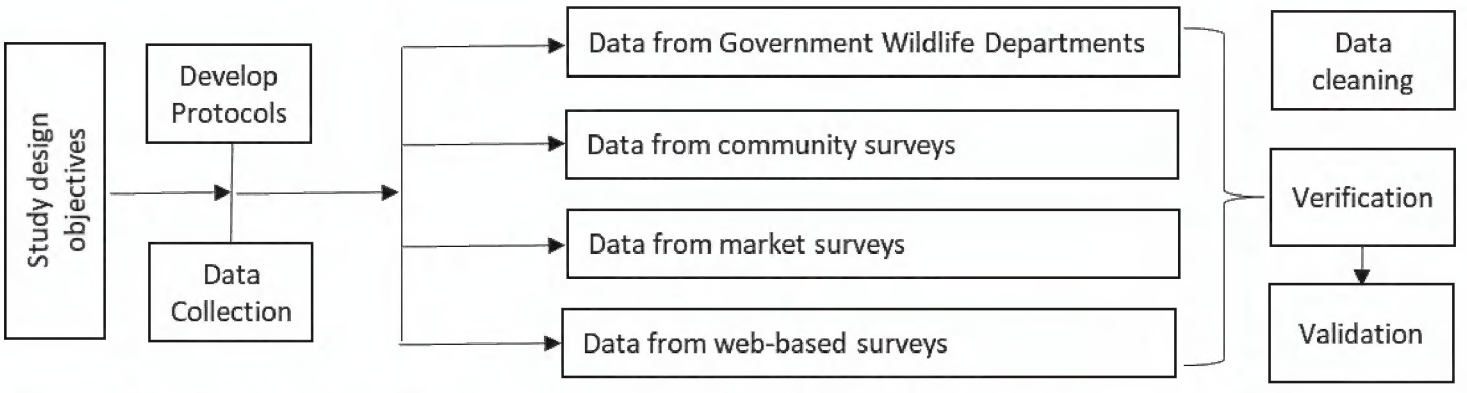

Figure 2. Schematic of methodological workflow adopted during the study.

ing Swat, Peshawar, Rawalpindi, Islamabad, Lahore and Karachi (Khan 2002b). We also conducted thorough surveys in each district of the snow leopard range, focusing on major markets in each town; i.e. district and tehsil (an administrative subdivision of a district) headquarters. A total of 97 shops in 17 different markets in the above-mentioned cities were visited as potential buyers and dealers of pelts and other parts of snow leopards (MaMing 2012; Aisha and Khan 2016; Maheshwari and Niraj 2018).

Subsequently, based on the information obtained so far, a separate questionnaire was developed to collect poaching and trade data from the local interviewee in the snow leopard range valleys, including herders, hunters, shopkeepers, local taxidermists, experts and other potential informants (See Suppl. material 1). We interviewed 180 respondents in different villages which are situated inside the snow leopard range in Pakistan. Care-

fully worded questions were asked from the respondents following Li and Lu (2014). Through the interview, questions were asked from the respondents, such as year, month, district and village where the animal was poached, sex of the animal, intention and reason of killing, whether the poacher was apprehended or not, where it was sold and who bought the specimen, what was the known price, how the animal was killed etc. Personal information, like the names and addresses of the respondents, were not recorded on paper to gain their confidence. The authors have a decades-long presence in the study area and have worked with the communities for a long time. We also identified 2–3 potential informants in the valleys, trained them in data collection and engaged them in the surveys, particularly in Hunza, Swat and Nagar Valleys, as they could speak the native language and have familiarity with the locals (MaMing 2012). To avoid an unrealistic and inflated number of snow leopard poaching, a poaching incident was considered, based on the presence of whole animal skin, photograph, the information provided by an expert in the field or a reliable eyewitness (Li and Lu 2014; Nowell et al. 2016). Other parts like teeth and claws were not considered separately to enumerate snow leopard poaching, while unverifiable reports were excluded from the final dataset before analysis. Thus, we report a minimum figure of snow leopard poaching in this paper.

Lastly, we conducted a desk review and online research for news related to poaching, apprehending, prosecution and smuggling related to snow leopards. Search engines such as Google and social media, like Facebook and Twitter, were scanned for similar posts and stories. Besides, we looked into the archives of major national and local online Urdu and English language newspapers. Data collected from different sources and tools were decoded in excel sheets, cleaned, verified and validated by filtering double counts and duplications to obtain the final data for analysis. To avoid double entries, particulars of each reported case from the community survey, government offices, expert opinions and news reports were tallied (Maheshwari and Niraj 2018). We used details of each case like date, sex of the animal, district and village where animals were poached or sold, price, description of poaching method, case registered, photographs and report of the eyewitness to filter the data and verify it (See Suppl. material 1). For instance, if a poaching case were reported by the government offices, non-governmental organisations, newspapers and other sources, it was counted only once.

Results

We recorded a total of 101 verified poaching observations. Most (87%) of the reported poaching incidences came from community surveys, followed by online observations (8%), departmental data (3%) and market surveys (2%), respectively. We were able to collect data (n = 101) from 11 out of 14 federating units (districts) within the snow leopard range (Fig. 1). Poaching incidences varied spatially (mean = 9 $\pm$ 2.6 [95% Cl: 3–15]). The distribution of poaching incidences reported per 100 km^2 was higher in Hunza District followed by Ghizer, Nagar and Gilgit (Fig. 1).

Snow leopard poaching and trade rate also mixed temporally. Average poaching incidences per year were estimated as 7.8 ± 1.09 during the study period (2005–2017). Similarly, poaching was higher during the winter months with average reported cases of 4.5 ± 1.10 (Fig. 3).

Poaching methods also varied (χ^2 [4, N = 101] = 138, $p < 0.05$). Shooting with a gun was most favoured (66%) over poisoning (12%), snaring (12%) and live captures (4%), out of the total cases (n = 101) reported. We could not confirm the remainder (6%) of the cases (Fig. 4). A significant variation (χ^2 [4, N = 101] = 152, $p < 0.05$) in the intention of stimulating poaching was also noticed in this study. Factors fostering snow leopard killing included livestock defence (68%), trade (21%), stuffing for decor (5%) and self-defence (4%), respectively. Intentions behind poaching in the remaining 3% of the cases were not known (Fig. 4).

Most of the animals killed were adults (n = 93), followed by subadults (n = 6) and cubs (n = 2). Similarly, out of the 101 poaching cases reported, 63 were male, 25 were female, while the sex of the remaining 13 was unknown.

The base price (price offered at the poaching site) and end price (commercial markets in large cities) of the animals poached varied significantly, t (21) = -2.8, $p < 0.05$. The average base price offered was 25,752 ± 3,824 PKR (245 ± 36 USD [1 USD = 105 PKR on 10 December 2017]) and ranged from 1,000 PKR (10 USD) to 70,000 PKR (667 USD). Similarly, the average end price was calculated as 182,295 ± 54,583 PKR (1,736 ± 520 USD) and ranged from 13,500 PRK (129 USD) to 750,000 PKR (7,143 USD), respectively.

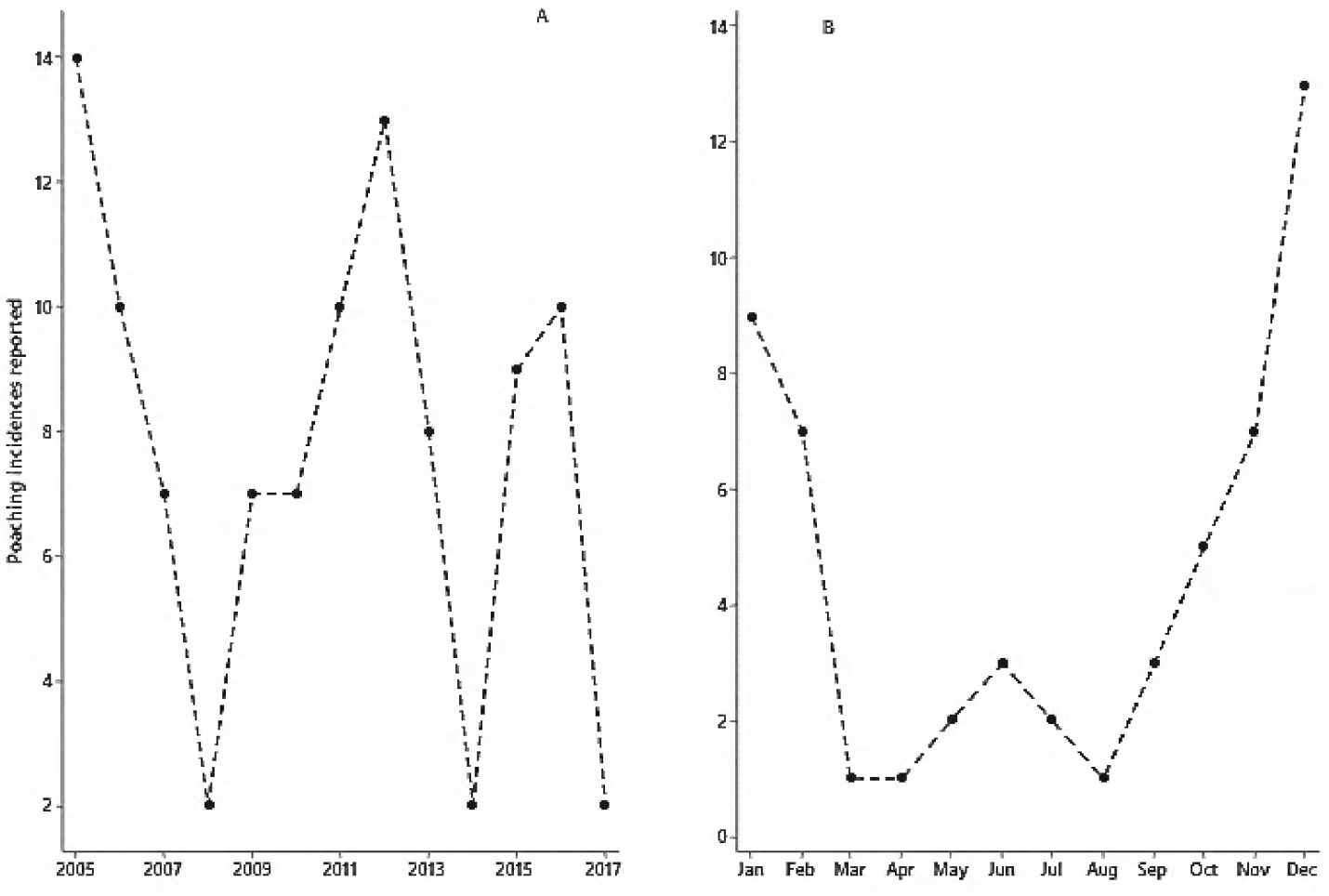

Figure 3. Temporal distribution (**A** Year-wise **B** Month-wise) of poaching incidences recorded.

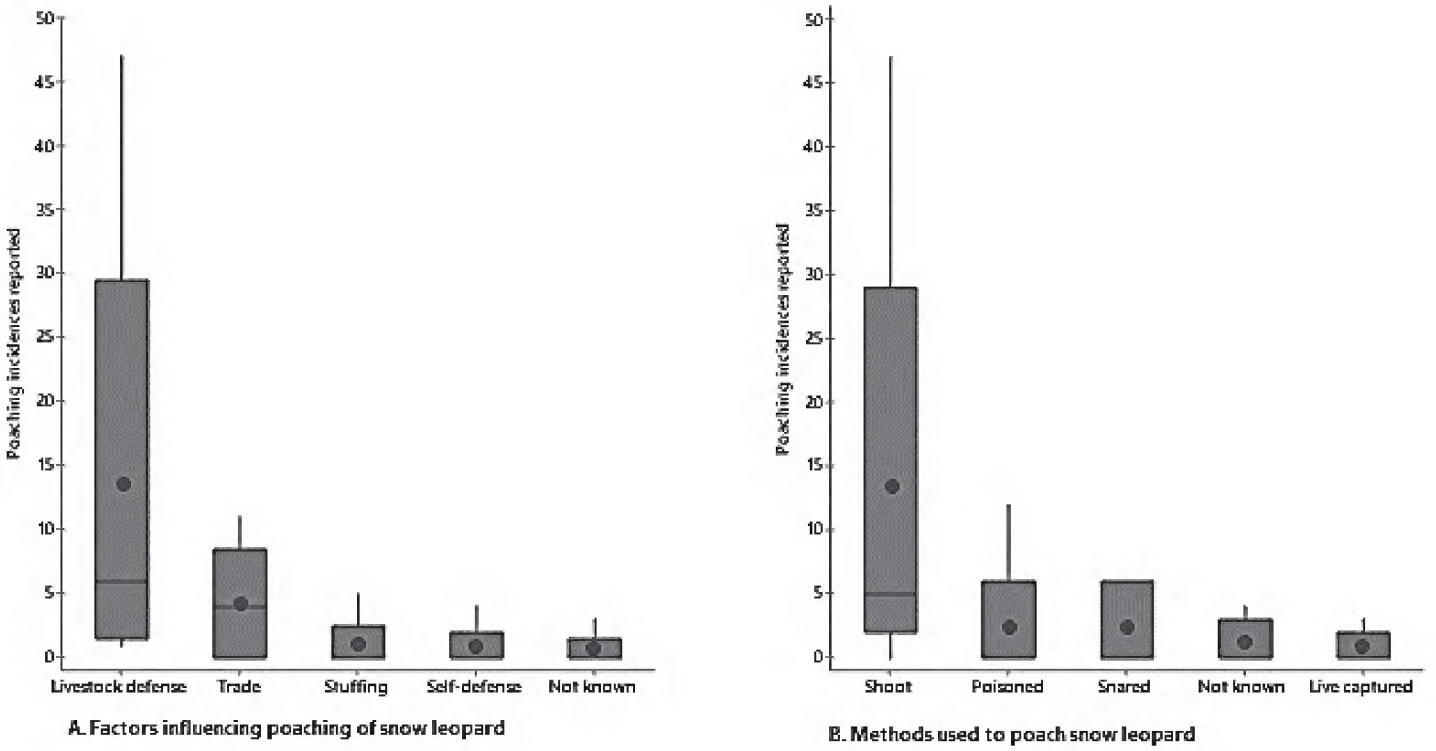

Figure 4. Poaching methods and factors influencing poaching of snow leopard.

Data collected from the respective wildlife departments revealed that the strength of the field staff was less than one person per 100 km^2 and most of the staff lacked proper field gear and transport facilities.

Discussion

Our study revealed that poaching and trade continue to be one of the main threats to snow leopards in Pakistan, as well as in other range countries (Maheshwari and Niraj 2018). About eight snow leopards were reportedly poached and traded per year, which constitutes 2–4% of the total snow leopard population (200–420) in the country (Din et al. 2016). It is believed that the snow leopard population may start declining if the annual mortality rate is > 21% (Chapron and Legendre 2002) and only a population > 15 females could endure a poaching rate of one individual/2 years (Li and Lu 2014). Application of the theorem to our findings reflects that 2–4% annual population loss would seem not to affect the snow leopard population in the country. However, documentation of poaching and trade in iconic species, such as snow leopards, is very difficult due to the secretive nature of the business, fear of reporting incidences and the lucrative monetary benefits associated with the illegal wildlife trade. Although utmost care was taken while conducting the survey, filtering, verifying and analysing the data obtained from various sources, yet the data presented here may not be free of error and potential bias. Some limitations may have been introduced due to the data collection method viz. questionnaires. Lack of reports from some areas of the snow leopard range and a higher number of poaching incidents from other areas may not reflect the actual scenario, but rather could be the result of more vigilance of the con-

tributors and familiarity of the data collector with the area. Similarly, the motivation behind snow leopard killing could not be correctly determined. Though the interviewee and experts were asked specific details about each case they reported, there is a possibility of error due to recall over a long period. Consequently, the data reported in this study are likely to cover a portion of the actual poaching and trade in snow leopards in the country. Moreover, we could not enumerate how many snow leopards died (both natural and poached) during the survey period. Secondly, reliable estimates of the snow leopard population are not available for the country (Ale and Mishra 2018). Therefore, it is difficult to determine the exact contribution of poaching to the annual mortality of snow leopards in the country.

Previous studies conducted in the global range of snow leopards (Nowell et al. 2016) and some neighbouring countries (Li and Lu 2014; Maheshwari et al. 2016) relied on internet searches, market and expert surveys. In this study, we included communities that live along with snow leopards in the data collection to enhance the accuracy and reliability of the data.

Contrary to our results, the TRAFFIC report (Nowell et al. 2016), based on an expert survey, estimated that 23–53 snow leopards are poached annually in Pakistan, which constitutes 12–13% of the estimated population in the country. Rashid et al. (2020) reported at least two snow leopards killed per year in the Khunjerab National Park and surrounding villages. Studies aimed at investigating sensitive issues, such as poaching and trade in iconic species, have management implications and must be planned with the utmost care to ensure a meticulous interpretation of the outcomes.

Spatial distribution and intensity of snow leopard poaching measured in this study can be subjected to access and availability of data, socioecological drivers, such as the abundance of snow leopards, the status of prey, effectiveness of the surveillance system and intensity of the human-carnivore conflict (Din et al. 2019), respectively. At a temporal scale, poaching incidences increased in the winter months. This is the time when snow leopards descend to lower altitudes following their wild and domestic prey and adapt to the comparatively smaller landscape, thus triggering mass livestock predation incidences (Din et al. 2017). Moreover, the mating season starts in winter (Dec-March), which is characterised by vocalisations and marking (Fox and Chundawat 2016). Thus, the climate and behaviour response of snow leopards make them prone to poachers and susceptible to poaching in the winter months.

Just like other parts of the snow leopard range (Theile 2003; Nowell et al. 2016), the retaliatory killing for predation on livestock remains the major driving force behind snow leopard poaching in Pakistan, followed by trade, for home décor and perceived self-defence. The human-snow leopard conflict has been a major socio-ecological issue in Pakistan and has resulted in a loss of up to two animals per household/year, with an economic impact of more than 200 USD per household (Din et al. 2017). Direct killing is, thus, driven by: (a) protection of livestock, which constitutes a major source of income for the communities in the snow leopard range and (b) trade in fur or other body parts. The latter, for most of the time, ends up in the marketing of fur or even the whole carcass (Theile 2003), although retaliatory killing and poaching for trade are dif-

ficult to differentiate (Li and Lu 2014). Motivation in the remaining cases was for decorative pieces and other luxury items. EIA (2012) and Li and Lu (2014) have reported a shift in snow leopard poaching towards luxury products. Unlike other parts of the snow leopard range, such as China (Li and Lu 2014; Nowell et al. 2016), the use of snow leopard parts in traditional medicines is not known in Pakistan. However, the presence of smuggling snow leopard parts to other neighbouring countries for medicinal use cannot be denied. The killing of juvenile snow leopards and live capture also supports this notion, as six sub-adults and two juveniles were reportedly killed during our study.

Our findings suggest that the frequently used method of poaching snow leopards is shooting in Pakistan, which is supported by other available studies (Nowell et al. 2016), while poisoning and use of snares are second and third amongst the common methods, respectively. However, where the intention of killing was trade, foot traps were preferred over the shooting (Theile 2003). In Pakistan, shooting and hunting guns are not banned; one only needs a licence from the Wildlife Department and people usually carry guns to high pastures, which makes it easier to use instead of other means of poaching. Secondly, snares need more technical skills and can be easily detected by field staff of line departments. Therefore, it is necessary to consider stricter regulations for shooting guns, while devising conservation measures for snow leopards in the country.

Snow leopard pelts and other body parts were reportedly transported to large cities, such as Peshawar, Islamabad, Rawalpindi and even Lahore and Karachi (Khan 2002a) for onward shipment to the Middle East and other countries (Khan 2002b). Similarly, poached animals or parts were also reportedly transported to China (Khan 2002a, b). Since Pakistan shares a long open border with Afghanistan, pelts and trophies of snow leopards and Marco Polo sheep (*Ovis ammon polii*) were reportedly smuggled to Pakistan as was reported in previous studies (Theile 2003).

Snow leopards are protected animals in Pakistan under provincial wildlife laws and listed in CITES Appendix I, thus prohibiting commercial international trade. However, a detailed analysis of the updated Wildlife Acts of the range provinces revealed that snow leopards and any other carnivore can be shot in self-defence or to defend livestock from a reasonable distance. Furthermore, the maximum monetary penalty proposed to kill a snow leopard is around 45,000 PKR (275 USD) or three years of imprisonment or both as per the revised Wildlife Act 2015. The monetary penalty is less than the monetary value of the snow leopard pelt in the local market. The maximum average market price we considered for a snow leopard was 182,295 PKR (1,736 USD [1 USD = 105 PKR on 10 December 2017]) and the minimum average price received was 13,500 PKR (129 USD) in 29 reported cases.

Law enforcement and strict regulations alone may not produce the required outcome for controlling snow leopard poaching when multiple socio-ecological factors like the rarity of the species, high incentives for poaching and higher demand for the parts of the animal are operating (Carter et al. 2014). Despite operational constraints, such as limited staff strength; i.e. < 1 person/100 km^2, lack of appropriate equipment,

gear and transport facilities in tandem with a complex and ever-changing combination of smuggling routes and concealments used by traffickers to avoid detection by enforcement agencies, provincial wildlife departments are doing well. In August 2020, two poachers were caught red-handed and were each fined 5 million PKR (> 30,000 USD [1 USD = 166.6 PKR]), along with imprisonment for one year in northern Pakistan (https://www.dawn.com/news/1572824).

This study is the first-ever attempt to draw attention to the conflicting issues related to snow leopard poaching and trade in the country. Detailed analysis of the dynamics of the poaching and trade in snow leopards indicates that snow leopards are persecuted annually in significant numbers with killing in retribution and trade being the major motives, earning ample revenue on the black market. Moreover, black markets exist not only both regionally and nationally, but also internationally. Laws protecting wildlife have loopholes and provide outlets for the culprits to escape. These gaps can be filled by improving existing laws and enhancing the strength of patrolling staff by equipping them with the required facilities. The mechanism can be further strengthened by developing a holistic and multi-stakeholder interprovincial governance mechanism involving a myriad of stakeholders ranging from customs, police, airport security forces and communities and the provision/application of forensic facilities at key points. The model can be replicated internationally by fostering transboundary management of illegal wildlife trade through information sharing and joint management of trans-border areas. The poaching incidents, reported here, may not be exclusive or accurate because informants are usually reluctant to report on the number of animals killed besides ensuring anonymity. The various socio-ecological factors involved in snow leopard poaching (Carter and Linnell 2016), not covered in this article, need to be elucidated for a greater understanding of the issue. According to Carter et al. (2017), it is necessary to understand the theoretical and empirical approaches regarding poaching in addition to other factors. Moreover, it is crucial to recognise the kinds of economic incentives that would benefit the conservation of snow leopards as a motivation, as the causes of poaching may not be limited to those revealed here. The currently known major causes of snow leopard killing, such as livestock predation, could be tackled by devising government-operated compensation schemes, which are mentioned in wildlife regulations.

Acknowledgements

The authors of this paper are indebted to all informants and investigators who participated in this study. The fieldwork was supported by the GEF-UNDP, PPG Grant for the development of PSLEP (Project ID:88620) and the University of Malaya (PPP Grant: PG002–2015B). The Wildlife Conservation Network (WCN) provided a scholarship for the Ph.D. study of Jaffar Ud Din. The publication of this article was funded by the Qatar National Library, Doha, Qatar.

References

Aisha H, Khan U, WWF-Pakistan (2016) An assessment of the scale of illegal wildlife trade in Pakistan. WWF-Pakistan, Lahore, Pakistan, 1–32.

Ale S, Mishra C (2018) The snow leopard's questionable comeback. Science 359(6380): 1110–1110. https://doi.org/10.1126/science.aas9893

Ayling J (2013) What sustains wildlife crime? Rhino horn trading and the resilience of criminal networks. Journal of International Wildlife Law and Policy 16(1): 57–80. https://doi.org/10.1080/13880292.2013.764776

Bending ZJ (2015) An introduction to the illegal trade in wildlife: A snapshot of the illicit trade in rhinoceros horn. AJEL 2: e123.

Carter NH, Linnell JDC (2016) Co-adaptation is key to coexisting with large carnivores. Trends in Ecology & Evolution 31(8): 575–578. https://doi.org/10.1016/j.tree.2016.05.006

Carter NH, Viña A, Hull V, McConnell WJ, Axinn W, Ghimire D, Liu J (2014) Coupled human and natural systems approach to wildlife research and conservation. Ecology and Society 19(3): e19. https://doi.org/10.5751/ES-06881-190343

Carter NH, López-Bao JV, Bruskotter JT, Gore M, Chapron G, Johnson A, Epstein Y, Shrestha M, Frank J, Ohrens O, Treves A (2017) A conceptual framework for understanding illegal killing of large carnivores. Ambio 46(3): 251–264. https://doi.org/10.1007/s13280-016-0852-z

Chapron G, Legendre S (2002) Some insights into snow leopard (*Uncia uncia*) demography by using stage-structured population models. Contributed Papers to the Snow Leopard Survival Strategy Summit, 48 pp.

Dexel B, Deutschland N (2002) The illegal trade in snow leopards: A global perspective. Citeseer, 1–34.

Din JU, Ali H, Nawaz MA (2016) The current state of snow leopard conservation in Pakistan. In: McCarthy TM, Mallon DP (Eds), Snow Leopards. Elsevier, New York, 486–491.

Din JU, Ali H, Ali A, Younus M, Mehmood T, Norma-Rashid Y, Ali Nawaz M (2017) Pastoralist-predator interaction at the roof of the world: Conflict dynamics and implications for conservation. Ecology and Society 22(2): art32. https://doi.org/10.5751/ES-09348-220232

Din JU, Nawaz MA, Mehmood T, Ali H, Ali A, Hasan Adli DS, Norma-Rashid Y (2019) A transboundary study of spatiotemporal patterns of livestock predation and prey preferences by snow leopard and wolf in the Pamir. Global Ecology and Conservation 20: e00719. https://doi.org/10.1016/j.gecco.2019.e00719

Din J, Hameed S, Ali H, Norma-Rashid Y, Adli D, Nawaz M (2021) On the snow leopard trails: Occupancy pattern and implications for management in the Pamir. Saudi Journal of Biological Sciences 29(1): 197–203. https://doi.org/https://doi.org/10.1016/j.sjbs.2021.08.071

EIA (2012) Briefing on snow leopards in illegal trade – Asia's forgotten cats. Environmental Investigation Agency, 2 pp.

Fox JL, Chundawat RS (2016) What is a Snow Leopard? Behavior and ecology. In: McCarthy TM, Mallon DP (Eds) Snow Leopards. Elsevier, New York, 13–21. https://doi.org/10.1016/B978-0-12-802213-9.00002-X

Gómez A, Aguirre AA (2008) Infectious diseases and the illegal wildlife trade. Annals of the New York Academy of Sciences 1149(1): 16–19. https://doi.org/10.1196/annals.1428.046

Hansen ALS, Li A, Joly D, Mekaru S, Brownstein JS (2012) Digital surveillance: A novel approach to monitoring the illegal wildlife trade. PLoS ONE 7(12): e51156. https://doi.org/10.1371/journal.pone.0051156

Hussain S (2003) The status of the snow leopard in Pakistan and its conflict with local farmers. Oryx 37(01): 26–33. https://doi.org/10.1017/S0030605303000085

Kabir M, Ghoddousi A, Awan MS, Awan MN (2014) Assessment of human-leopard conflict in Machiara National Park, Azad Jammu and Kashmir, Pakistan. European Journal of Wildlife Research 60(2): 291–296. https://doi.org/10.1007/s10344-013-0782-z

Kahler JS, Gore ML (2012) Beyond the cooking pot and pocket book: Factors influencing noncompliance with wildlife poaching rules. International Journal of Comparative and Applied Criminal Justice 36(2): 103–120. https://doi.org/10.1080/01924036.2012.669913

Khan J (2002a) Report on Snow Leopard Pelt Trade Survey. TRAFFIC Europe unpublished report, August 2002.

Khan J (2002b) Report on Snow Leopard Pelt Trade Survey. TRAFFIC Europe unpublished report, February 2002.

KP Wildlife Department (2015) Khyber Pakhtunkhwa Wildlife and Biodiversity Act 2015, 34 pp. http://kpwildlife.com.pk/Downloads/wildlife_act_2015.pdf

Lavorgna A (2014) Wildlife trafficking in the Internet age. Crime Science 3(1): e5. https://doi.org/10.1186/s40163-014-0005-2

Li J, Lu Z (2014) Snow leopard poaching and trade in China 2000–2013. Biological Conservation 176: 207–211. https://doi.org/10.1016/j.biocon.2014.05.025

Maheshwari A, Niraj SK (2018) Monitoring illegal trade in snow leopards: 2003–2014. Global Ecology and Conservation 14: e00387. https://doi.org/10.1016/j.gecco.2018.e00387

Maheshwari A, Niraj SK, Sathyakumar S, Thakur M, Sharma L (2016) Snow leopard illegal trade in Afghanistan: A rapid survey. CAT News 64: 57–58.

MaMing R (2012) Market prices for the tissues and organs of snow leopards in China. Bekenov AB, Blank DA [Israel], Brushko ZK, Yang W [China, Xinjiang] (Eds). Selevinia 516: 119–122.

McCarthy T, Mallon D, Jackson R, Zahler P, McCarthy K (2017) *Panthera uncia*. The IUCN Red List of Threatened Species 2017: e. T22732A50664030.

MOCC (2017) National Snow Leopard and Ecosystem Priorities (NSLEP). Ministery of Climate Change, Islamabad, Government of Pakistan, 40 pp.

Nowell K, Li J, Paltsyn M, Sharma RK (2016) An ounce of prevention: Snow Leopard crime revisited. TRAFFIC, Cambridge, UK, 73 pp.

Oldfield S (2003) The trade in wildlife: regulation for conservation. Routledge, 232 pp.

Rashid W, Shi J, Rahim I, Dong S, Sultan H (2020) Issues and opportunities associated with trophy hunting and tourism in Khunjerab National Park, northern Pakistan. Animals (Basel) 10(4): e597. https://doi.org/10.3390/ani10040597

Ripple WJ, Estes JA, Beschta RL, Wilmers CC, Ritchie EG, Hebblewhite M, Berger J, Elmhagen B, Letnic M, Nelson MP, Schmitz OJ, Smith DW, Wallach AD, Wirsing AJ (2014) Status and ecological effects of the world's largest carnivores. Science 343(6167): e1241484. https://doi.org/10.1126/science.1241484

Sheikh KM, Molur S (2004) Status and red list of Pakistan's Mammals, based on the conservation assessment and management plan. IUCN Pakistan, Islamabad, Pakistan, 312 pp.

Theile S (2003) Fading footprints: the killing and trade of snow leopards TRAFFIC International. Cambridge, UK, 84 pp.

Toledo LF, Asmüssen MV, Rodríguez JP (2012) Track illegal trade in wildlife. Nature 483(7387): e36. https://doi.org/10.1038/483036e

Vié J, Hilton-Taylor C, Stuart S (2009) Wildlife in a changing world: an analysis of the 2008 IUCN Red List of Threatened Species, 184 pp. https://books.google.com/books?hl=en&lr=&id=hgErHErt6-gC&oi=fnd&pg=PR7&dq=Stuart,+2009+wildlife&ots=umnmJqk1Hr&sig=VnDKxQS2p1vgirhcVtOKM3c1418

Yi-Ming L, Zenxiang G, Xinhai L, Sung W, Niemelä J (2000) Illegal wildlife trade in the Himalayan region of China. Biodiversity and Conservation 9(7): 901–918. https://doi.org/10.1023/A:1008905430813

Supplementary material 1

Questionnaire 1

Authors: Jaffar Ud Din, Fathul Bari, Hussain Ali, Ejaz ur Rehman, Durriyyah Sharifah Hasan Adli, Nurul Ashikin Abdullah, Yusoff Norma-Rashid, Muhammad Kabir, Shoaib Hameed, Doost Ali Nawaz, Muhammad Ali Nawaz

Data type: pdf file

Explanation note: Questionnaires used to collect data on snow leopard poaching and trade in Pakistan.

Copyright notice: This dataset is made available under the Open Database License (http://opendatacommons.org/licenses/odbl/1.0/). The Open Database License (ODbL) is a license agreement intended to allow users to freely share, modify, and use this Dataset while maintaining this same freedom for others, provided that the original source and author(s) are credited.

Link: https://doi.org/10.3897/natureconservation.46.76036.suppl1